ARJUNA

JEE

LECTURE - 08

Atomic structure

Sarvesh sir

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Q. The electronic velocity in the fourth Bohr's orbit of hydrogen is V. The velocity of the electron in the first orbit of helium ion would be:

60 Sec

A 4 V

B 8 v ✓

C V/8

D 16V

$$v = 2.188 \times 10^{8} \frac{Z}{n} \text{ cm/sec}$$

$$v = 2.188 \times 10^{8} \frac{1}{4} \quad \text{—(i)}$$

$$v_{He^+} = 2.188 \times 10^{8} \times \frac{2}{1} \quad \text{—(ii)}$$

$$\frac{v}{v_{He^+}} = \frac{1}{8}$$

$$\boxed{v_{He^+} = 8v}$$

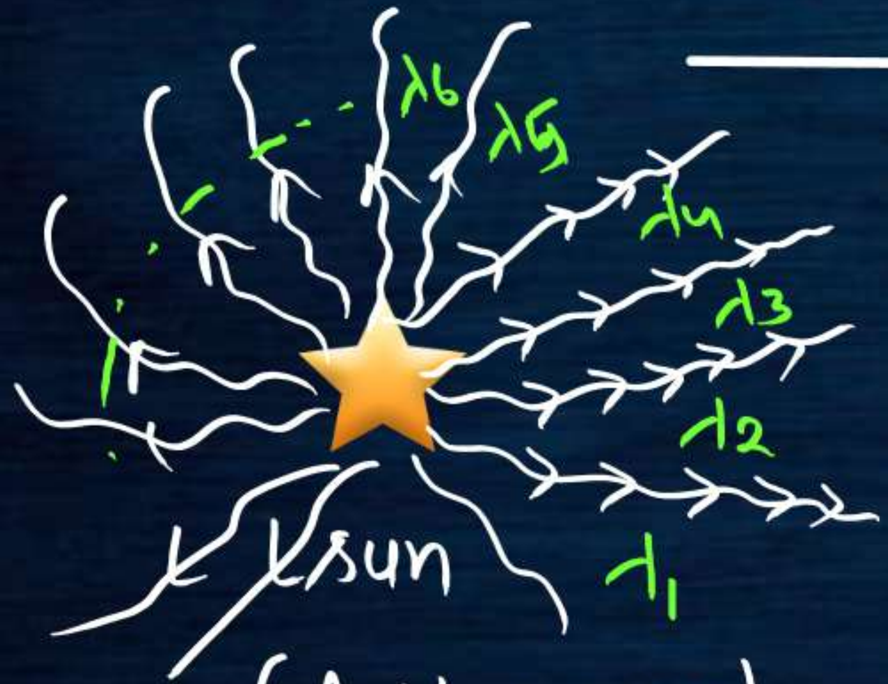
M-2

$$\frac{v_1}{v_2} = \left(\frac{Z_1}{Z_2}\right)\left(\frac{n_2}{n_1}\right)$$

$$\frac{v}{v_{He^+}} = \left(\frac{1}{2}\right)\left(\frac{1}{4}\right)$$

$$v_{He^+} = 8v$$

SPECTRUM



Arrangement of different wavelength in increasing or decreasing order in known as spectrum

$\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4 < \lambda_5 < \text{- - -}$

↳ spectrum

sun (ligh source) → electro-magnetic spectrum

C	Y	X	U	V	I	M	R	

Cosmic ray | γ-ray | X-ray | Ultra violet | Visible | Infrared | micro wave | Radio wave

→ Arrange in increasing order of wavelength (λ)

$$E = h\nu = \frac{hc}{\lambda}$$

→ $\nu = \frac{c}{\lambda} \Rightarrow \nu \propto \frac{1}{\lambda} \Rightarrow$ decreasing order of frequency (ν)

Q. Select the region in which maximum wavelength release (emit)

(a) Ultra-violet (U)

(b) Visible (V)

(c) Infra-red (I) ✓✓

(d) X-rays (X)

Ans batao

$\lambda \rightarrow \uparrow \rightarrow$ C Y X U V (I) M R

↓

increasing order of wavelength

Visible Region → 3800 – 7600 Å

V	I	B	G	Y	O	R
Violet	indigo	Blue	Green	yellow	orange	Red

→ Arrange in increasing order of λ → $V < I < B < G < Y < O < R$

→ Arrange in increasing order of ν → $V > I > B > G > Y > O > R$

Q Arrange increasing order of wavelength

green (G), Red (R), Violet (V)

Ans batao

(a) G > R > V → x

(b) G < R < V → x

✓ (c) V < G < R

(d) None of these

VIBGYOR → λ ↑

Q → match the following

ⓒ Y X UV ⓘ MR →

List-1	List-2
(a) green ⎫ ν	(p) maximum wavelength (p → c)
(b) Red ⎭	(q) minimum wavelength (q → d)
(c) = Infrared	(r) Visible region (r → a, b)
(d) Cosmic rays	

Spectrum

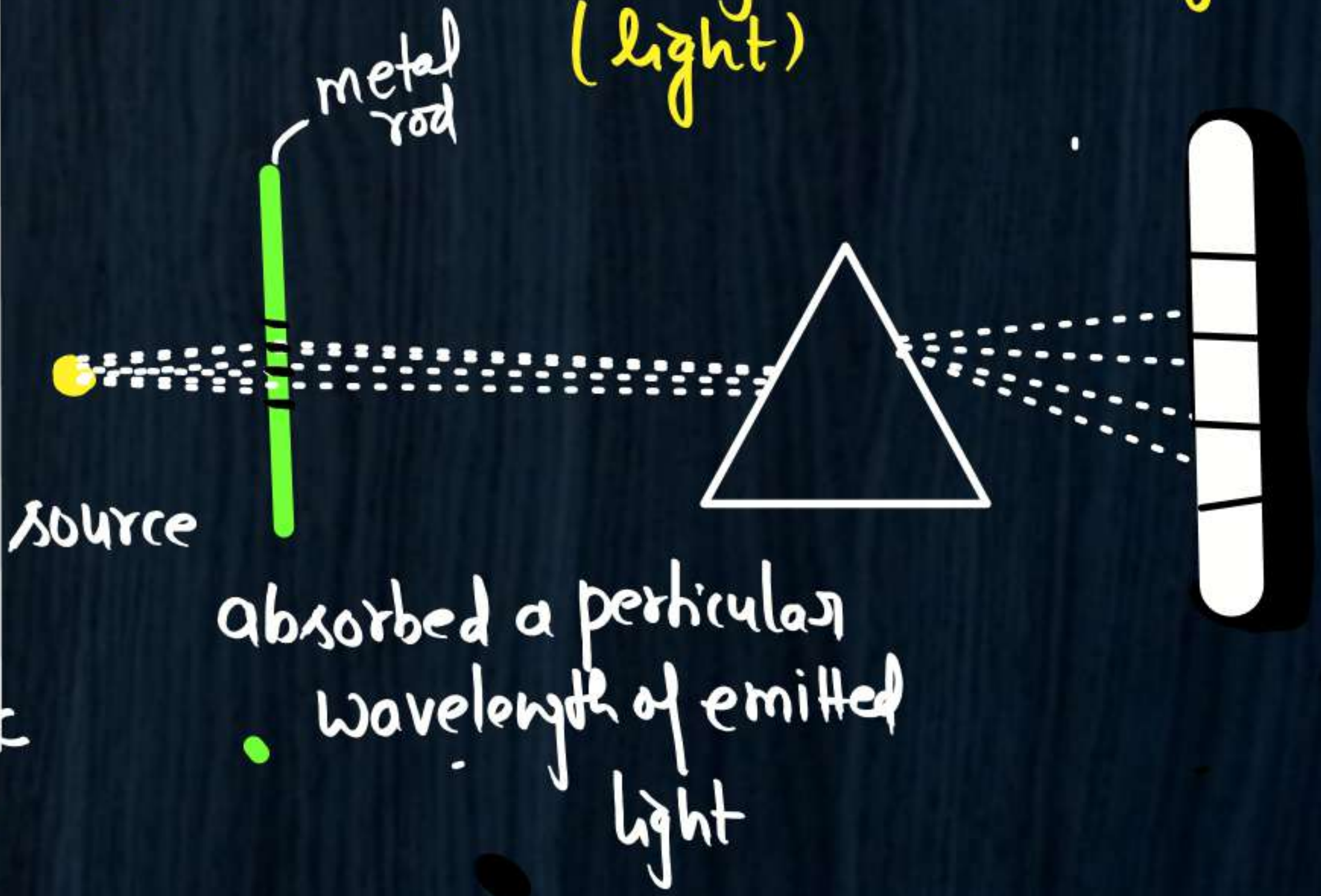
Emission spectrum

→ spectrum form by emitted light

→ black sheet pr white line aati hai

Absorption spectrum

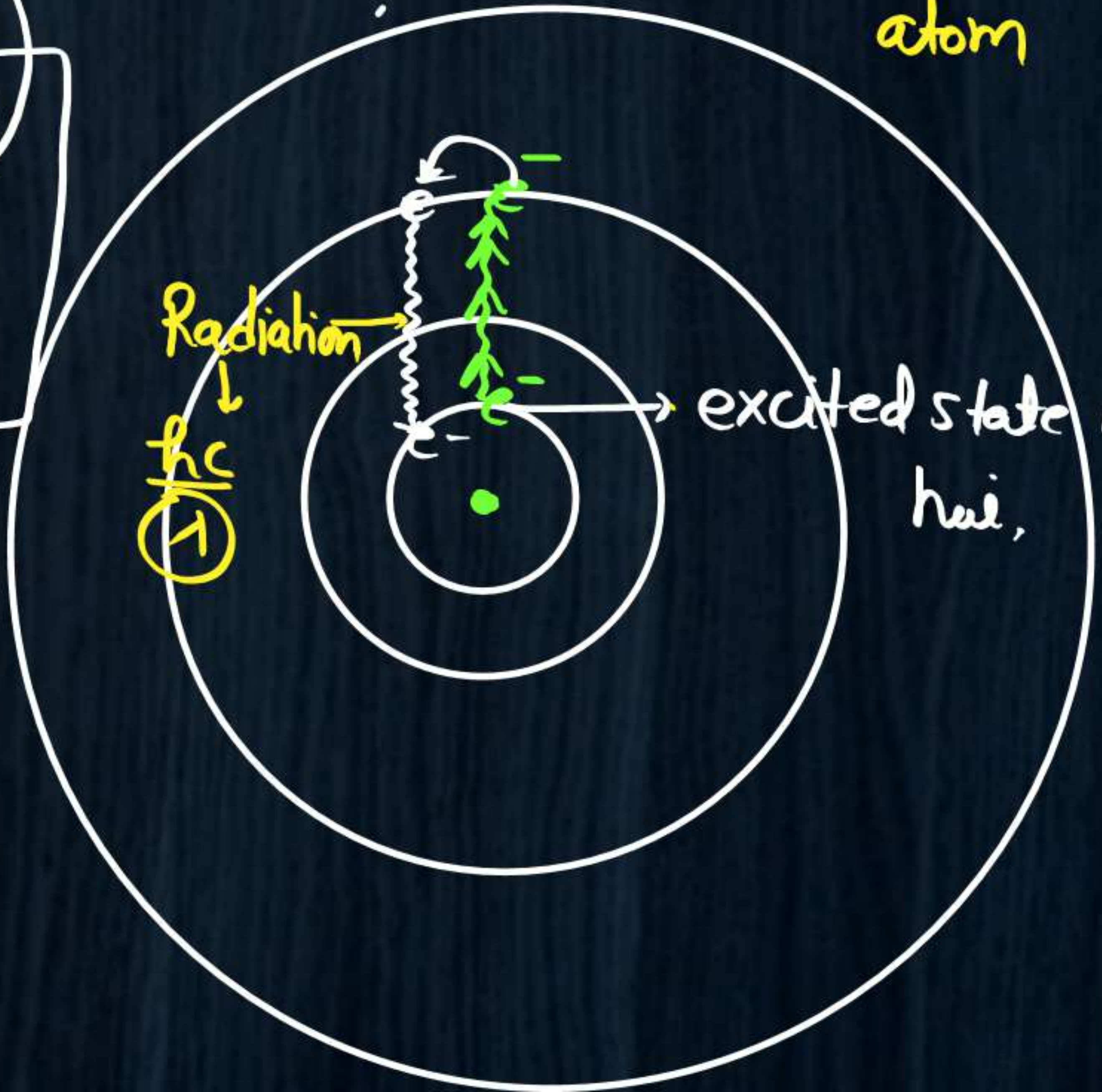
spectrum form by absorption of wavelength (light)



Hydrogen spectrum

$H - H \longrightarrow H + H$

atom atom



→ excited state me ja raha hai,

Ⓧ $\longrightarrow H \rightarrow H^+ + e^-$ → ionisation

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

<u>Where</u> → λ = emitted wavelength

Z = Atomic No.

R → Rydberg Constant

R = 109677

n_1 = lower Energy level

n_2 = upper Energy level

(2) Hydrogen spectrum only applicable for 1 single e^- species

Ex ⇒ H, He^+, Li^{+2}, Be^{+3}

Ex → He → ⓧ

Q - Hydrogen spectrum is applicable

(a) H (1 e^-)

(b) Li^{+2} (3 e^- - 2 e^- = 1 e^-)

(c) He^+ (2 e^- - 1 e^- = 1 e^-

✓ (d) All

$C_{SD} = 20$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Shortest wavelength ($\lambda_{min.}$)

$$\lambda_{min} \propto \frac{1}{(\Delta E)_{max}} \Rightarrow n_2 = \infty$$

Lyman → $n_1 = 1$

longest wavelength (λ_{max}) $\Rightarrow \lambda_{max} \propto \frac{1}{(\Delta E)_{min.}}$

$\Delta E = \frac{hc}{\lambda} \Rightarrow \boxed{\Delta E \propto \frac{1}{\lambda}}$

↓

energy gap between two energy level

Lyman s. = $n_1 = 1, n_2 = 2$

Q. Calculate longest wavelength of Lyman series in H-atom

(a) $\frac{R}{4}$

(b) $\frac{3R}{4}$

(c) $\frac{4}{3R}$ ✓

(d) None of these

Longest wavelength = $n_1 = 1$, $n_2 = 2$

$\lambda_{max} \propto \frac{1}{(\Delta E)_{min}}$

$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\frac{1}{\lambda} = R(1)^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$\frac{1}{\lambda} = R\left(\frac{3}{4}\right)$

$\boxed{\lambda = \frac{4}{3R}}$

Q Calculate shortest wavelength of Lyman series in He^+ ion.

(a) $4R$

(b) $\frac{1}{4R}$

(c) $\frac{1}{R}$

(d) None of these

Shortest wavelength (λ_{min}) $\rightarrow n_2 = \infty$

$n_1 = 1$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = R(2)^2\left(\frac{1}{1^2} - \frac{1}{(\infty)^2}\right]$$

$$\frac{1}{\lambda} = 4R$$

$$\lambda = \frac{1}{4R}$$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Shortest(λ)

longest (λ)

Lyman → $n_1 = 1$ → $\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{n_2^2}\right)$ → $\lambda_{min} \Rightarrow n_2 = \infty$ $\lambda_{max} = n_1 + 1 = 2$

Balmer → $n_1 = 2$ → $\frac{1}{\lambda} = RZ^2\left(\frac{1}{2^2} - \frac{1}{n_2^2}\right)$ → $\lambda_{min} \Rightarrow n_2 = \infty$ $\lambda_{max} = n_1 + 1 = 3$

Paschen → $n_1 = 3$ → $\frac{1}{\lambda} = RZ^2\left(\frac{1}{3^2} - \frac{1}{n_2^2}\right)$ → $\lambda_{min} = n_2 = \infty$ $\lambda_{max} = n_1 + 1 = 4$

Bracket → $n_1 = 4$ → $\frac{1}{\lambda} = RZ^2\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right)$ → $\lambda_{min} = n_2 = \infty$ $\lambda_{max} = n_1 + 1 = 5$

Pfund → $n_1 = 5$ → $\frac{1}{\lambda} = RZ^2\left(\frac{1}{5^2} - \frac{1}{n_2^2}\right)$ → $\lambda_{min} = n_2 = \infty$ $\lambda_{max} = n_1 + 1 = 6$

Q. Calculate longest wavelength of Balmer series for H-atom

(a) $\frac{4R}{9}$

(b) $\frac{9}{4R}$

(c) R

(d) None of these ✓✓

$n_1 = 2$ (Balmer)

$n_2 = n_1 + 1 = 3$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = R(1)^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\frac{1}{\lambda} = R\frac{5}{4 \times 9}$$

$$\boxed{\lambda = \frac{36}{5R}}$$

Home work

pw-modules

Topicwise Question → Q.No- 18 to 24

Learning plus = 1 to 11 Question

Thank - You

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